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IMPERIAL BUREAU OF PLANT GENETICS: HERBAGE PLANTS

BULLETIN No. 1.

MISCELLANEOUS INFORMATION RELATING TO BREEDING OF HERBAGE PLANTS

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(12/1815)Q

I. PROGRESS OF BUREAU ROUTINE.

THE indexing of current literature is now proceeding as a regular part of the activities of the Bureau. The Supplement accompanying this Bulletin will show the journals upon which we can draw for information. In addition, arrangements have been made whereby access has been gained to certain of the central libraries in the country, thereby assisting in the tracing of references not to be found in Aberystwyth.

Short abstracts are generally taken of papers of interest.

Translations of foreign articles are made, and copies prepared for circulation, on loan, to research workers on herbage plants throughout the Empire. If any worker wishes to peruse an abstract which is not included in our Bulletins, or a translation which was not listed in our Circular Letter No. 1, the Bureau will do everything possible to assist in supplying these requirements. Certain duplicates of papers are available on loan to workers for short periods.

There is also under preparation a comprehensive index of research workers on grassland and herbage plants generally, throughout the world. As forecast in the Circular Letter, steps are being taken to acquire accurate information as to the actual breeding work being carried out by workers on the Continent ; later, it is hoped to extend this to the United States of America. By combining these data with the replies received from the Empire, a detailed survey of the present position of breeding of herbage plants should be possible.

With regard to the publication of the Bulletin from the Bureau of Plant Genetics (Herbage Plants), we hope to produce further Bulletins periodically. These will either be of a general nature, such as the present number, or will deal with some particular subject. The publication of the data on breeding and cultural methods as applied to lucerne will probably be undertaken at an early date.

II. METHOD IN BREEDING TECHNIQUE.

The methods employed by workers in the breeding of herbage plants are of primary importance, especially to such persons as are commencing research on some new problem. At a later date a review of such methods may be undertaken by the Bureau, but in the meantime the inclusion of extracts such as those to be found below may be of some value.

KIRK, L. E. **Abnormal seed development in sweet clover species. A new technique for emasculating sweet clover flowers.** *Scientific Agriculture*, Vol. X, No. 5, p. 321. Ottawa, 1930.

The following is a detailed account of the method which is used for emasculating and pollinating sweet clover flowers. Roots are taken up early in the spring and transplanted into a greenhouse which has been screened to exclude bees and other insects. It is convenient to have the plants growing in a large box, about two feet deep, constructed on the floor of the greenhouse, as this gives the maximum space above for plant growth. A water tap to provide the necessary suction pressure should be located in the vicinity. A filter pump, $\frac{3}{8}$-inch pressure hose, vacuum flask and glass nozzle, completes the equipment. The vacuum flask is inserted in the hose line. A short piece of glass tubing to fit the hose, and drawn out to a bore of slightly less than 1 mm. in diameter, makes the nozzle. The fine point of the latter must be carefully smoothed in a flame in order that it may not injure the delicate parts of the flower.

The amount of suction maintained in the hose is of considerable importance. Water pressure at taps is usually quite variable, especially in midsummer, when sprinklers are being used on the lawns. Best results were secured in these experiments by working early in the morning, when the pressure was least variable. It is possible that lowered pressure was responsible for the poor results obtained in the few instances recorded in the tables. If the pressure is above 30 pounds, a Cenco-Harrington aspirating pump can be used with advantage, because of its greater efficiency than the ordinary pump. Under these conditions, good results may be expected.

Running water, of course, is not the only means for creating a partial vacuum. An electrically-driven suction pump or other mechanical means could easily be devised for this work and made to maintain a uniform suction pressure. Portable devices also, for use in the field, could be easily constructed.

The success of the "suction" method of emasculating depends upon the thoroughness with which all of the stamens and adhering pollen are removed. A raceme is chosen on which some of the flowers at the tip have not yet opened. These are removed, together with many of the older flowers at the base of the raceme, leaving only about twenty or less of the recently expanded blossoms. The petals of the flowers to be manipulated are then pulled off with suitable tweezers. This invariably ruptures the stamens and scatters the pollen. Water is turned on at the tap and the nozzle applied to the flowers for the purpose of removing both stamens and adhering pollen.

The nozzle should approach the stamens from the base or side of the staminal tube, and if the suction is sufficiently strong, the stamens will be quickly and easily taken in. If the flower is approached from the top, the pistil and staminal tube will be drawn in with force. This results in coating

the inside of the nozzle with sticky fluid, to which the pollen grains adhere. Under these circumstances, it is probable that there is a tendency for the pollen grains to become attached to the stigma so strongly that they cannot always be removed. It is an advantage if the inside of the nozzle is kept dry.

When the operator is at work, he should wear a low-power binocular magnifier on the head, leaving his hands free. An instrument of this kind is regarded as essential for best results. Indeed, it is doubtful if good work can be done without it, as it is difficult to observe with the naked eye that all the stamens have been removed. When the magnifier is worn, the pollen grains also are plainly visible. While one cannot hope to see that every pollen grain has disappeared, it is possible to tell with a reasonable degree of certainty when this has been accomplished. Having first removed the stamens, the operator proceeds to pass the end of the nozzle over the surface of each style and stigma, and also over the sepals and axis of the raceme.

Having made reasonably sure that the stigmas are free from pollen, crosses are made by pollinating the emasculated flowers immediately. Removing the petals and leaving the pistil exposed does not appear to interfere with seed setting. Pollinating may be done most effectively by applying the pollen to the stigmas with the end of the thumb-nail.

[Extract from article, pp. 324-326.]

KNOLL, J. **Untersuchungen über den Einfluss der künstlichen Isolierung auf die Fruchtbarkeitsverhältnisse bei Phleum pratense, Avena elatior, und einigen anderen Grasarten.** [Investigations on the influence of artificial isolation on the fertility of *Phleum pratense, Avena elatior* and some other grass varieties.] *Wiss. Archiv. Landw. A. Pflanzenbau*, Vol. II, p. 318. Berlin, 1929.

(1) There is a distinct negative correlation between seed setting and the absolute air moisture ratio in *Phleum pratense* and *Avena elatior*, which was proved both in artificial isolation and pollination under protection and in the open.

(2) The yield-decreasing effect of high absolute air moisture was found in every case, whether the increase of absolute moisture were to be ascribed to a rise in temperature or to the relative moisture. The dependence of seed setting on these two factors is complicated, temperature and relative moisture influence each other mutually in their effect upon seed setting.

(3) The degree of absolute air moisture ratio is influenced by the isolation paper. The lowest absolute moisture and the high seed setting were to be found when the protective cages were made of parchment, whilst the oiled and waxed isolation covers showed higher absolute moisture and lower seed

setting. The permeability of parchment makes it more suitable for isolation purposes, a quality which is lacking in papers impregnated with oil and wax. Parchment paper has furthermore the advantage of admitting more light.

(4) The absolute moisture and with it the seed setting are also influenced by the number of plants isolated and the size of the isolation chamber. The more plants are enclosed together, the greater in general is the absolute air moisture ratio and the less the seed setting. If, however, the absolute moisture ratio falls with increase in the number of plants, than the seed setting increases. The highest relative seed setting was attained by isolation of flowering stands in panicle cases. White parchment paper was found to be best for this purpose. This kind of enclosure produces enough seed for practical breeding purposes and is at the same time the simplest and cheapest. Care must, however, be taken that too many flowers are not enclosed together. In our experience from five to ten inflorescences was the best number. When panicles alone are isolated leaf transpiration and evaporation from soil surface are lacking, which increase the relative and therewith the absolute air moisture ratio.

(5) The flower transpiration is, however, so strong that the inclusion of a few more panicles in the chamber has an immediate effect on the absolute moisture ratio and seed setting. With an increasing number of flowers isolated the possibility of pollination is certainly increased, but in consequence of the flower transpiration the absolute moisture increases and seed setting decreases. The amount of pollen which a plant produces has no influence on the degree of seed setting.

(6) There are great differences with regard to self fertility in the cases of *Phleum pratense, Avena elatior, Dactylis glomerata, Lolium perenne, Festuca pratensis, F. arundinacea,* and *Poa pratensis* respectively. Although in all grasses the great majority showed little seed production, in nearly every case, with the exception of *Agrostis alba* and *Avena flavescens,* individuals were to be found, which, apparently because of especially favourable temperature and moisture conditions, attained during inflorescence a seed setting comparable with that of free flowering plants.

(7) If amongst the isolated members of a clone individual and yearly variations in seed setting appear, these may presumably be ascribed to frequently changing absolute moisture during inflorescence.

(8) With cross pollination under cages higher seed setting was attained than with self pollination. Here also was seen the dependence of seed setting on the degree of absolute moisture and the superiority of parchment paper to oiled papers.

(9) The following factors are most important in influencing seed setting in artificial isolation, the behaviour of the individual with regard to self fertility

and the degree of absolute moisture, which is affected by the type of paper used and the number of flowers enclosed.

(10) We consider the last and chief cause of low seed setting in cages to be the injury of pollen by high temperature and moisture.

(11) The experience of growers that annual weather conditions influence the degree of seed production in *Gramineae*, may be borne out by the fact that high absolute moisture lowers seed setting of *Phleum pratense* and *Avena elatior* even with free pollination.

It must remain an open question how far the fact that certain crosses only succeed in some years or with certain persons is connected with the attainment or not of the optimum absolute moisture condition. Perhaps many hitherto inexplicable discrepancies in literature on the subject may be ascribed to insufficient consideration of temperature and moisture conditions. There are, however, various questions still open whose solution requires further investigation.

III. NEW STRAINS OF HERBAGE PLANTS.

The following notes on the production of new strains may be of some general interest. Their inclusion in this Bulletin does not necessarily indicate that their ultimate success is assured.

A new variety of Sweet Clover is reported from Saskatoon, Canada (L. E. Kirk, Alpha Sweet Clover. *Unvy. Saskatchewan Agricultural Extension Bulletin No.* 45, 1929). The author points out that common white flowered or yellow flowered biennial sweet clover cannot be regarded as an ideal forage crop, although it is useful for pasture purposes and unexcelled " as a nitrogen gathering and soil improving crop." Alfalfa, however, produces better hay. The new Sweet Clover appears to possess the most desirable qualities of both. The plants in question arose in a field of Arctic Sweet Clover at Saskatoon ; a search of the eight-acre field showed the presence of forty of these aberrant types, only six of which were fully fertile. A full description has already appeared in *Scientific Agriculture* (L. E. Kirk, " Aberrant forms in Arctic Sweet Clover," *Scientific Agriculture*, V. p. 113, 1924-25). It is assumed for the moment that this new form is a result of a natural cross between sweet clover and alfalfa or some other legume, or that it is a mutant form of common sweet clover.

By in-breeding and selection, three or four lines have been produced for further study. The plants included in these lines " are only one-half to two thirds as tall as common sweet clover, and very much finer stemmed and more leafy." This fine leafy growth is never any coarser than alfalfa when " both

are seeded broadcast or in drills." On the other hand, the new plants resemble common white-flowered sweet clover in biennial habit of growth, and produce flowers, pods and seeds which are indistinguishable from the latter. Among the other characters of the new strain which were studied were " winter hardiness, yield of forage, disease resistance, seed production, feeding value and qualities which effect soil fertility."

No line now being used shows winter killing. Two of the three strains studied show a high degree of resistance to stem canker (*Ascochyta caulicola*). It was found that the Alpha variety had a greater percentage of leaf, and yielded approximately the same ; in other words, " lack of height probably was compensated by the more numerous leafy stems which produced a much denser growth." Chemical analyses showed a higher protein content and a decrease in fibre of approximately four to seven per cent. In the final conclusions the author states that " it will require time and larger quantities of seed to fully test the agricultural value of this new variety. The results thus far have been very encouraging, and it is hoped that some of the strains will fill places of special usefulness."

While on the subject of sweet clover, the article by D. H. Jones and E. H. Garrard on " Early *versus* late ploughing of sweet clover for green manure " (*Scientific Agriculture*, Vol. X, No. 6, p. 419, 1930) is of some interest. The authors summarise their results as follows :—" The nitrogen content of a sweet clover crop that was intended for green manure was determined weekly from April 26th until June 17th to ascertain the advisability of leaving the crop as long as possible before ploughing it on account of increase of nitrogen. From April 26th to May 23rd there was an increase of total nitrogen from 13·8 to 76·1 lbs. per acre. During the next three weeks this amount of nitrogen was again nearly doubled, rising from 76·1 to 133·1 lbs. per acre. The percentage of this nitrogen that was obtained from the atmosphere was not determined."

To return to the subject of new strains, reports have been received of two new varieties of alfalfa in the United States of America. The first, probably of Turkestan origin, has as its main feature a degree of resistance to winter-killing and to the bacterial wilt (*Aplanobacter insidiosum*). " Hardistan " is the name assigned to this variety by the Nebraska College of Agriculture. (T. A. Kiesselbach, Arthur Anderson and G. L. Peltier. " A New Variety of Alfalfa (Hardistan). *Journ. Amer. Soc. Agronomy*, Vol. XXII, No. 2, p. 189, 1930). The source of the seed of this new variety was an old superior field of alfalfa which, 16 years after sowing, showed a practically perfect stand. Hay-yielding capacity was determined over a seven-year period ; this showed 4 per cent. superiority over Nebraska Common, compared with five per cent. superiority for the Grimm variety. A markedly superior, full and uniform stand eight years after sowing is good evidence of winter-hardiness. Wilt infection data in 1928 showed 71 per cent. infected in Nebraska Common,

67 per cent. in Grimm and 28 per cent. in Hardistan. In appearance and growth Hardistan closely resembles the Common variety. Although supposed to be originally Turkestan, it does not show the typical characteristics of Turkestan lucerne.

The second new variety of lucerne has been mentioned in correspondence with certain North American workers. This strain, which goes under the name of Ladak lucerne, is supposed to have originated in the mountains of Northern India. Mr. H. L. Westover states that " it has given promising results in those Northern States where the moisture supply is limited. It seems to be more resistant to a combination of cold and a limited moisture supply than any other alfalfa available. Producing a heavier first cutting than other alfalfas, it is especially valuable for those sections where only one cutting is normally obtained. As it recovers slowly after cutting, it usually falls down in the second crop, and does not appear to have much promise for the more humid districts."

The following section dealing with research on herbage plants in other countries will be found to include references to further new strains which have been raised.

IV. RESEARCH ON HERBAGE PLANTS IN SWEDEN.

The Bureau proposes to publish at intervals information, as recent as possible, regarding the progress of breeding of herbage plants in foreign countries. In the following notes, various aspects of the position in Sweden are dealt with.*

(*a*) Practical Breeding Work.

Lolium perenne.—Two new strains are being compared with the well-known Svalöv " Victoria," in field trials at Svalöv. At Weibullsholm, Mr. F. Nilsson has made hand crosses under controlled conditions between selected plants. A large number of seedling and yearling plants are being studied. These are mostly raised from open-pollinated seed ; a fair proportion were undoubtedly hybrids between *L. perenne* and *L. multiflorum.* Some very good hay-type plants have arisen. It is claimed that two new strains, Nos. 633 and 644, now included in field trials, are highly rust-resistant, heavy-yielding, and hardy.

Lolium multiflorum.—Weibullsholm has a new strain on the market, " Weibull's Imperial." Some very good plants have been obtained by selection from their own Imperial and from Tystofte No. 152.

Dactylis glomerata.—Six new lines originating from the well-known Svalöv Skandia cocksfoot are being tested. Breeding work is less extensive

* In the preparation of this section some use was made of T. J. Jenkin's " Plant Breeding Methods and Technique in Demark, Sweden and Norway," 1929.

than with timothy, but general procedure is similar. Extensive clone studies are undertaken. Some inter-crossing is done, both by enclosing the inflorescences of two plants together, or by conveying pollen from one plant to another (no emasculation). *D. glomerata* and *D. Aschersoniana* are crossed by the latter method. The latter species is fairly common, especially in beech woods in Southern Sweden. It is distinctly less harsh than *D. glomerata*, but does not thrive well in the open. The object of breeding is to combine the smoothness of *D. Aschersoniana* with the hardiness and vigour of *D. glomerata*. The F_1 plants are intermediate. The inheritance of anthocyanin pigment in *D. glomerata* is also being studied. Two Weibullsholm strains, Tardus and Minerva II, are included in field trials at Svalöv, while five other new strains are in small field trials at Weibullsholm.

Phleum pratense.—This is the most important grass species in Sweden and Norway, owing to its wide use in temporary leys. In mid-Sweden and Norway, farmers generally harvest their own seed, usually from a ley in the third harvest year. Thus the same strain may be perpetuated indefinitely on the same farm, producing automatically a large number of local strains. The well-known Svalöv strain, Gloria, still remains standard at this station, while several new strains are being compared with it. Attention in the past has been concentrated on a type with more or less broad leaves, tall, strong stems, relatively few tillers, and usually rather lacking in leaf. Clone beds are studied. Plantlets within a clone are selfed, while open-pollinated seed is also harvested. A general comparison is made between the two types as regards loss of vigour. A type of timothy comparable with the Aberystwyth extreme pasture type has been found. Breeding and selection work are also active at Weibullsholm ; two strains, Kämpe and Kämpe II, are on the market.

Festuca pratensis.—At Svalöv several new strains are being tested against the older Svalöv Late and Svalöv Early. Breeding is not extensive, but the same system is followed. Weibull's Mimer, which is on the market, has been selected from an older Weibullsholm strain.

Alopecurus pratensis.—This species is little used ; it is considered to be of greatest value under extreme conditions, *e.g.*, on *Sphagnum* peat.

Festuca rubra.—With greater attention being paid to pasture plants (as distinct from hay), this species has been taken in hand at Svalöv. At Weibullsholm work is rather more advanced, but no strain has reached the field plot stage.

Arrhenatherum elatius.—Some selected strains at Svalöv have reached the small field trial stage.

Poa trivialis.—This species tends to be regarded more or less as a weed in Northern Sweden and Norway.

Poa pratensis.—Selection work is in progress at Weibullsholm, where some fine plants occur. With the increasing study of pasture types, this species should receive more attention.

Poa palustris.—This species is found to be valuable for *Sphagnum* peat areas. There is a seed production area at Flahult, in Sweden.

Other grass species studied are *Festuca ovina* (Dr. Göte Turesson on ecotypes) and *Agrostis stolonifera.*

Trifolium pratensis.—This species is by far the most important clover in Scandinavia. It is, in fact, probably the most important herbage species, being a constituent of all seeds mixtures. The reason for the use of timothy to such an extent in mixture with red clover is the fact that it matures at approximately the same time. The main aims of the breeders throughout Scandinavia are rather similar ; a successful red clover strain must show a suitable degree of winter-hardiness and must be capable of persisting and yielding well under hay conditions over three harvest years.

At Svalöv, breeding work is not very extensive, although considerable importance is attached to the self-fertility problem. In the study and selection of plants, much use is made of the clone system. The genetical study of leaf-marking is also in progress at Weibullsholm. Swedish late flowering plants are being crossed with early flowering types to obtain a productive and hardy strain, somewhat earlier than the ordinary late, and also with wild red types with a view to obtaining greater persistency.

Trifolium repens.—The average opinion regarding English wild white clover is that it is not sufficiently winter-hardy for Denmark and South Sweden. There is no breeding work with white clover in progress in Sweden, but at Svalov a new strain produced at a sub-station is being compared with the Danish and other strains.

Trifolium hybridum.—No selection or breeding work.

Medicago.—Little will be said regarding lucerne, as this plant will be dealt with in detail in a later Bulletin. One of the most important questions in lucerne breeding in Germany, Denmark and Sweden is seed setting capacity, and selection is frequently based upon this factor. At Weibullsholm, Grimm lucerne sets seed very poorly. At Svalöv, selections have been made from Grimm, and also from the progeny of a natural cross between *Medicago sativa* and *M. falcata* ; some of this material is in field trials. At Ultuna the conditions are much more severe than at Svalöv, and great importance is attached to winter-hardiness. Seed setting capacity and the question of male sterility are being investigated. The problem of self-fertility is considered to be of great theoretical importance.

(*b*) Theoretical Breeding Work.

At Weibullsholm, Mr. F. Nilsson is studying supposed natural interspecific hybrids between *Festuca arundinacea* and *F. gigantea,* and inter-

generic hybrids between *Lolium perenne* and *Festuca arundinacea*, and between *Lolium multiflorum* and *Festuca arundinacea*. At Svalöv, Dr. Nilsson-Ehle is dealing with four distinct theoretical problems in cereals, which need not be further elaborated at this point.

(*c*) Seed Production Problems.

Owing to the large area under cereal crops, isolation of small lots of herbage plants for seed production is relatively easy. Thus many different strains of the same species can be carried forward to the field trial stage. Considerable attention has been paid to the drill width suitable for seed production ; it has been found that for cocksfoot, timothy, meadow fescue, red fescue, *Poa pratensis* and *Agrostis stolonifera*, a drill width of 45 cm. gives the best results. In most cases, the application of nitrogenous manures has been found to increase the seed yield. Timothy and cocksfoot benefit, while *Poa pratensis* gives a decreased yield.

The practice of farmers in harvesting their own seed of timothy and red clover is an important feature in Sweden.

(*d*) List of Stations, with Investigators.

Svalöf ... Plant Breeding Station, Svalöf, Skåne, Sweden.
Professor H. Nilsson-Ehle, Ph.D., M.D., Professor of Genetics at the University of Lund.
Nils Sylvén, Ph.D. Head of Department of Forage Plants.
G. Nilsson-Leissner, Ph.D. Assistant. Pasture plants.

Ultuna ... Sub-Station of the Svalöf Plant Breeding Station, Uppsala, Uppland, Sweden.
R. Torssell, M.Sc.

Ölvingstorp... Sub-Station of the Svalöf Plant Breeding Station, Småland, Sweden.
O. Holmgren.

Weibullsholm Plant Breeding Station, Landskrona, Skåne, Sweden.
F. Nilsson, M.Sc.
In addition, Mr. G. Eriksson is working at Bosstorp, (retiring 1930).

V. CURRENT LITERATURE.

(*a*) Abstracts.

Church, G. L. **Meiotic phenomena in certain Gramineæ. Aveneæ, Agrostideæ, Chlorideæ and Phalarideæ.** *Botanical Gazette*, Vol. LXXXVII, p. 608. 1929.

The author gives a detailed description of the cytological conditions examined by him in thirteen species of the above-named groups : the haploid basic number is seven. The writer found diploid, tetraploid, hexaploid and

octoploid forms. Of the species examined the writer considers *Phalaris arundinacea* alone a pure species, all the others in his opinion are hybrids. He concludes this from the irregularities in the reduction division occurring in all of them, and the partial sterility of the pollen occasioned thereby. Good illustrations give a picture of the cytological processes described. The author proceeds to give a review of the polyploid series hitherto known, their probable origin by hybridisation and their significance for the problem of the formation of species.

[Translation of abstract by Schick. *Fortschritte der Landwirtschaft*, Vol. V, No. 2, p. 73. 1930.)

FOULDS, Frank E. **A study of the comparative morphology of the seeds of Agropyron.** *Scientific Agriculture*, Vol. X, No. 3, p. 200. *Ottawa*, 1929.

Brome grass brought seed of *A. repens* (couch grass) with it from Russia. *Agropyron tenerum* (slender wheat grass) used as a forage crop is known in commercial seed trade as western ryegrass. Analyses of seed samples at Winnipeg show 45 per cent. of all samples of brome and 5 per cent. of samples of western ryegrass contain seeds of couch grass. Field percentages are similar. The seeds of the various species of *Agropyron* cannot be distinguished from one another except under magnification. For seeds of *A. repens*, *A. Smithii*, and *A. tenerum*, no single character may be chosen as an infallible indicator, but the student must become familiar with the shape and pubescence of the rachilla, the delineation and pubescence of the callus, the tip of the palea, and the awn.

FRANDSEN, H. N. **Lidt om frøavl af stortoppet rapgræs, Eng. rapgræs og rød svingel.** [A note on seed production of *Poa fertilis*, *P. pratensis* and *Festuca rubra*.] *Tidsskrift for Frøavl*, Vol. IX, No. 19, p. 367. Roskilde, 1930.

Poa fertilis.—This grass is little used in Denmark in spite of its high hay yield in mixtures with red clover and lucerne. Sowing for several years seed production can be made in drills 40-50 cm. apart, 6-8 kg. per hectare. Used for hay or grazing first harvest year. Seed harvest taken second and third years. Manuring treatment is described. Ripening and harvesting occur in early July.

Poa pratensis.—Spreads in soil by rhizomes. Seed probably produced by same area for several years. Growth slow, so no yield obtained in first harvest year. May be sown with or without a thin, stiff strawed nurse crop, or mixed with early red clover, then used for hay or grazing. Seed small and poor in germination. Should be sown in drills 10 cm. apart. 12-14 kg. per hectare. High manurial requirement. Ripening and harvesting in early June. Thrashing and cleaning somewhat difficult.

Festuca rubra.—Little used for grass or seed production. Used for permanent pasture on drier soils and on poor peat meadows. Largest seed

yield to be obtained on good loamy soils. Seed production methods similar to those for *Poa pratensis*. No flowering stems in first harvest year. Certainly makes very heavy demands for manuring. Seed yield probably maintained for several years if sufficient manuring.

FRUWIRTH, C. **Die Grundlagen und der heutige Stand der Rotkleezüchtung.** [The principles and present position of red clover breeding.] *Casove otazky ceskosl. Akad. Zemed.*, H. 15, No. 1, 1929.

The breeding of clover varieties has been confined hitherto to quite a small number of experimental stations, in spite of its great importance. The knowledge available as to the carrying out of breeding work is also very scanty. Therefore it is all the more satisfactory that so well known an authority on plant breeding as Dr. C. Fruwirth should have undertaken the task of working up this difficult subject, and, in addition to giving his own experiences, of collecting and reviewing such material as is available. The first part of the work treats of the principles of red clover breeding (fertilisation conditions, changes of population, regulation of fertilisation, increase, bred strains and improved strains in particular, breeding by selection of spontaneous variations, by segregation and by hybridisation). In the second part, the author gives a review of the present position of red clover breeding. The appended bibliography giving 98 articles on the subject, is also of value.—[Translation of abstract by Heinisch. *Fortschritte d. Landwirtschaft*, Vol. V, No. 3, p. 119, 1930.]

JENSEN, FREDE. **Frøavl af rodkløver.** [Seed production of red clover. *Dansk Frøavl*, Vol. XII, No. 16, p. 143, *and* No. 17, p. 153. *København*, 1929.

Seed production of red clover has long been practised in Denmark. There seems to be no doubt that when clover gained admittance into Denmark about the beginning of last century seed production of the species was practised directly.

For satisfactory seed setting the stand should not be too heavy and dense. Here on the Islands the growers who use a heavy rate of seeding —16 to 18 lb. per 1·4 acres—find that it pays to cut or graze first, while those who use a rate of seeding of 10 to 12 lb. find it most advantageous to take seed from the first cut.

A very dense stand impedes fertilisation. In a dense stand, particularly in unfavourable weather, it is difficult for the flowers to dry satisfactorily and insects find it more difficult to work in such a stand than in a more open one.

For production of clover seed a rate of seeding of 7-8 kg. per hectare will, under good germination conditions, generally be sufficient for broad casting; a somewhat smaller quantity should be used for sowing in drills.

In the cases of early red clover, seed should only be taken from the second cut after an early first cut.

A first cut of early red clover will, as a rule, not give a yield of seed worth mentioning. The chief reason is that the insects which pollinate clover do not occur in sufficient numbers so early in the summer. It is generally assumed that early red clover yields less seed than late red clover. The author holds firmly to the opinion, however, that it is the time of flowering which is decisive in regard to the relation between the yield of seed of early and of late red clover. A large number of growers of early red clover make the mistake of harvesting the first cut of the seed field too late, so that flowering of the second cut for seed occurs too late.

Seed production of red clover should certainly be still more widely practised in Denmark.

LEVY, E. BRUCE, and DAVIES, WILLIAM. **Strain Investigation Relative to Grasses and Clover.** (2) **Cocksfoot (Dactylis glomerata).** *New Zealand Journal of Agriculture*, Vol. XXXIX, No. 6, p. 363. Wellington, 1929.

This paper is the second of the series, the first having dealt with perennial rye-grass. The present subject is the better utilization of cocksfoot in New Zealand pastures. Strain tests of 119 lines are being carried out at the Plant Research Station. The outstanding feature is the difference between Danish and New Zealand cocksfoot, the superiority of the latter being very marked as regards pasture type, winter burn, etc. The urgent need for systematic seed production of these superior types, both for home use and export, is stressed.

MAHLING, M. **Die Nutzung und Züchtung des Rohrglanzgrases.** [The utilization and breeding of reed canary grass (*Phalaris arundinacea.*)] *Grünland und Landeskultur*, Vol. VII, No. 1, p. 2. Berlin, 1930.

Reed canary grass, although hitherto recognised as a valuable fodder plant, especially in certain parts of Germany, has only recently become a systematic inclusion in seed mixtures for moist, meadow lands. Thriving quite well on fairly dry soils it is, however, better suited for river and sea coast lowlands, for irrigated meadows, probably for moorlands and certainly for all conditions too damp for other grasses. Under such circumstances it produces an early and luxurious growth and, when harvested at the correct stage of development, a fairly nutritious hay crop. On arable land, where the water table and quality make the growing of red clover or lucerne impossible, it can be sown alone and utilised for green fodder, hay or silage. As a pasture plant its value is questionable for, whereas some authorities are of the opinion that it is adversely effected by the trampling and cropping of animals, others say that it stands grazing admirably.

Owing to its tendency to unequal ripening and to its liability to shed its seed, harvesting operations are most difficult. Various methods are employed but as yet none are absolutely efficient. This, together with the fact that until recently the only seed available has been that harvested from wild stands, is the reason for the high price of the seed and, thus, its less general use. By reducing to a minimum the quantity sown per acre the situation might be improved.

Consequent upon its increasing popularity many plant breeders have been endeavouring to produce improved strains, working on such points as :— (i) The relation of stalk to leaf. (ii) The production of smooth leaf blades and sheaths. (iii) Resistance to disease, especially rust. (iv) Higher and more assured seed yields. (v) Earlier ripening. (vi) Firmness of glume. (vii) Resistance to drought. (viii) Uniformity.

An increase in amount of herbage produced appears to be of secondary importance. Some success has already been obtained and further developments along the lines indicated should lead to a much more extensive use of this valuable species.

R. A. C.

Minnesota Experiment Station. Bulletin 252. **Reed Canary Grass.** By A. C. Arny, M. C. Hansen, R. E. Hodgson, and G. H. Nesom, 1929.

Reed canary grass (*Phalaris arundinacea*) has been found, especially in South Central Minnesota, to fill a definite need for a high-yielding, nutritious hay and pasture crop on many comparatively small areas of low, poorly drained lands, mostly of a peaty nature. Information is given on its history, adaptation, plant and seed characteristics, cultural needs, use, feeding value and seed production. Feeding tests in comparison with timothy, wild hay, and alfalfa hay for cows and the germination percentages and other data for seeds with varying amounts of colour in their hulls are noted briefly.— [*Experiment Station Record*, Vol. LXI, No. 4, p. 331, 1929.]

Poijärvi, Ilmari. **Ett försök att bestämma timotejhöets och klöverblandat timotejhös foderenhetsvärde direkt med ledning av dess analys.** [An experiment to determine the fodder unit value of timothy hay and of timothy hay mixed with clover directly guided by analysis.] *Beret. om Nordiske Jordbrugsforskeres Forenings Fjerde Kongres Helsingfors.* 1929, p. 152.

By determination of digestibility alone the fodder unit value of the hay cannot be indicated accurately. A simultaneous production experiment with milking cows furnishes a much more certain basis for calculation ; but the tediousness of the method prevents its general use. The author has therefore taken up the investigation at the same time with sixteen digestibility experiments with the varieties of hay mentioned and milk production experiments with eleven varieties.

The fodder unit value of timothy hay can be calculated fairly accurately by the digestibility of its organic matter, which again can be found to 10 per cent. accuracy from the hay's content of N-free extract, fibre and amides in the manner specified in the paper, assuming that the fodder unit values which are obtained by the mode of calculation of Hansson, Møllgaard and Kellner are correct. This applies only to timothy hay and to timothy hay with at most 40 per cent. clover, and does not apply when the hay is harvested during emergence of panicles (*aksdannelsen*) or long before flowering. For other varieties of hay, special tables are necessary. [Translation of abstract in *Tidsskrift f.d. Norske Landbruk.* Vol. XXXVI. *Supplement,* p. 23. 1929.]

STAEHLIN, Adolf. **Morphologische und zytologische Untersuchungen an Gramineen.** [Morphological and cytological research on *Gramineae.*] *Wiss. Archiv. Landw. A. Pflanzenbau.* Vol. I. No. 2, p. 330. 1929.

The relationship of the chromosomes to phylogeny is probably of little value for practical plant breeding ; we know now, however, that in artificially multiplying the chromosome number we need fear no undesirable specialisation of form, for increasing the chromosome number seems to have less connection with this than with the enlargement of the organ and with strengthening of growth. From this it would appear that if we can succeed in obtaining " polyploid " forms, in which, after further research, we shall doubtless be successful, a yield increase will be ensured. The limit, however, of a profitable increase of chromosome number lies possibly between hexaploidy and octoploidy. [Translation of author's summary.]

STAPLEDON, Reginald George. **Pasture values.** *Essex County Farmers' Union Year-book.* 1930, p. 202.

This article impresses upon the farmer the necessity for rotational grazing. The evidence accumulated at Aberystwyth and elsewhere supports " the golden rule which is applicable to all grasslands : Graze and rest alternatively ; in other words, adopt some sort of a rotational system of grassland management." The following general principle is also emphasised : " When the quality of the grasses is good and the conditions of growth excellent, the correct policy is to lengthen out the period allowed for growth ; this, however, involves the necessity of turning a very large head of stock in to the folds or fields as and when necessary. On the other hand, when the quality of the grasses is poor, and the conditions not particularly favourable, the rest period should be relatively short."

SYLVEN, Nils. **Själv- och korsbefruktning hos timotej och hundäxing.** [Self- and-cross fertilization in timothy and cocksfoot.] *Beretning om Nordiske Jordbrugsforskeres Forenings Fjerde Kongres i Helsingfors.* 1929, p. 670.

The author began experiments to find (1) if totally self-sterile types of timothy occur, (2) if "varying tendencies for self-sterility" (Witte) could possibly be considered as due to a certain extent to defective pollination during isolation, (3) what method of isolation could be considered to give the best pollination and fertilisation results. Isolations were of several types: "Free single isolation," "fixed single isolation," "free joint isolation," "fixed joint isolation," and "mass isolation."

It was found that totally self-sterile types occur only rarely, in three of the forty-one cases studied (7·32 per cent). In these cases, self-sterility was due to complete male sterility. High self-sterility to almost complete self-sterility was found in nine cases, or 21·95 per cent. For all but one of the examples studied isolation was found to be unfavourable for seed setting. Artificial cross pollination has been favourable to seed setting. In cocksfoot also a variety of degrees of self-fertility occurs, from complete self-sterility to particularly effective self-fertility. One clone was completely self-sterile, while the majority showed more or less high self-sterility. No male sterility was ascertained in these clones.

Again in cocksfoot isolation showed itself unfavourable to seed setting. Seed setting from free flowering plants was decidedly better than from isolation with or without artificial cross pollination. Artificial cross-pollination is as favourable for seed setting in cocksfoot as in timothy.

VINALL, H. N., and CROSHY, M. A. **The Production of Johnson Grass for Hay and Pasturage.** *U.S. Dept. Agriculture Farmers' Bulletin,* No. 1597. 1929.

The native sorghum of the Mediterranean districts of Europe, Africa and Asia (*Sorghum halopense L.*) was introduced into the United States of America in 1830, where it received the name of Johnson grass, after the farmer who first cultivated it to a large extent. South of the 38th deg. of latitude the grass spreads prolifically, especially on the good soils of the river lowlands. Because of its powerful rhizomes it is very difficult to eradicate it from any place in which it has once established itself, and for this reason often makes the growing of cotton and other crops impracticable. Instead of trying to exterminate the Johnson grass and to cultivate crops it is often better to use such pieces of ground as Johnson grass meadows. The authors do not recommend the actual planting of Johnson grass meadows, but show rather how the grass may be best employed where it has already established itself. The bulletin discusses conditions of growth, cultivation, irrigation, hay production, fodder value and pasture production of Johnson grass, which, rightly

cured, offers a valuable fodder almost comparable to timothy. Under good conditions (irrigation) yields of 70-140 dz. are reported. (dz. = Doppelcentner = about 2 cwt.). [Translation of abstract by König. *Fortschritte der Landwirtschaft*, Vol. V, No. 3, p. 112. 1930.]

WILLIAMS, Rhys David. **Comparative Agronomic Values of Red and White Clovers of Different Origin.** *Journ. Dept. Agriculture of Ireland.* Vol. XXVIII, No. 1, p. 67. 1929.

The data considered in this paper are largely drawn from the results of the investigations at Aberystwyth. The importance of strain in red and white clovers is emphasized. In the case of red clover, it is shown that the late varieties, particularly Montgomery late and Cornish marl, are much better suited for the western and northern parts of the country than the early clovers on account of their greater productivity and longevity. The red clovers from South Europe are shown to be totally unsuitable to our conditions. A brief resumé of the chief characteristics of the most important varieties is given. In the case of the white clovers, wild white is shown to be greatly superior to the ordinary white, with New Zealand white occupying an intermediate position.

(*b*) MISCELLANEOUS PAPERS INDEXED.

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ASTON, B. C. **Lucerne a lime-rich plant. Analyses of Otago samples.** *New Zealand Journal of Agriculture*, Vol. XXXVIII, No. 6, p. 397. Wellington, 1929.

BROWN, Dennis. **Lucerne : stray thoughts on its cultivation and use.** *Essex County Farmers' Union Year-book*, 1930, p. 140. Chelmsford, 1930.

CARLETON, John W. **Seasonal behaviour of alfalfa flowers as related to seed production.** *Journal of the American Society of Agronomy*, Vol. XX, p. 542. Washington, 1928.

CEYLON, Department of Agriculture. *Bulletin No.* 84. **Fodder grass trials on the Experiment Station, Peradeniya.** By T. H. Holland. Colombo, 1929.

CREBERT, H. **Beiträge zur Kreuzungstechnick der Leguminosen.** [Contribution to the technique of the hybridisation of *Leguminosae.*] *Der Züchter*, Vol. II, No. 3, p. 85. Berlin, 1930.

DANSK FRØAVL. **Lucernefrø fra Turkestand, som er immunt mod svampesugdom.** [Lucerne seed from Turkestan which is immune from " wilt."] *Dansk Frøavl.*, Vol. XII, No. 12, p. 117. København, 1929.

FENTON, E. **Wyllie. A botanical study of hay plots.** *Annals of Applied Biology*, Vol. XVII, p. 107. Cambridge, 1930.

HELMBOLD, Friedrich. **Untersuchungen über die Befruchtungsverhältnisse, über die Bedingungen und über die Vererbung der Samenerzeugung bei Luzerne** (*Medicago sativa* **und Bastardluzerne**). [Investigations on the fertilization, on the conditions and inheritance of seed-producing ability in lucerne (*Medicago sativa* and hybrid lucerne)]. *Zeitschrift für Pflanzenzüchtung*, Vol. XIV, p. 113. Berlin, 1929.

HICKS, F. W. **Tasmanian pastures. II. Crimson clover.** (*Trifolium incarnatum*). *Tasmanian Journal of Agriculture*, Vol. I, No. 2, p. 52. Tasmania, 1930.

HUDSON, E. R. **Tasmanian pastures. I. General considerations.** *Tasmanian Journal of Agriculture*, Vol. I, No. 2, p. 48. Tasmania, 1930.

JONES, D. H., and GARRARD, E. H. **Early versus late ploughing of sweet clover for green manure.** *Scientific Agriculture*, Vol. X, No. 6, p. 419. Ottawa, 1930.

KENNEDY, P. B. **Proliferation in** *Poa bulbosa*. *Journal of the American Society of Agronomy*. Vol. XXI, No. 1, p. 80. Geneva, N.Y., 1929.

KIRK, L. E. **Alpha sweet clover.** *Reprint University of Saskatchewan Agricultural Extension Bulletin No.* 45. 1929.

KIRK, L. E. **The Improvement of western rye grass,** *Agropyron tenerum*, **Vasey.** *Scientific Agriculture*, Vol. X, No. 4, p. 239. Ottawa, 1929.

MOODIE, A. W. S. **Methods of establishing improved pastures.** *Agricultural Gazette of New South Wales*, Vol. XLI, No. 1, p. 1. Sydney, 1930.

NATURE. **Rice grass** [*Spartina Townsendii*] **and land reclamation.** Vol. CXXIV, No. 3137, p. 931. London, 1929.

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NILSSON, F. **Resultaten från å Weibullsholm utförda vitklöverförsök 1926-28.** [Results from white clover trials at Weibullsholm.] *W. Weibull's Illustrerade Årsbok No.* 24, p. 22, 1929.

ODLAND, T. E. and GARBER, R. J. **Tests of native and foreign clover strains in West Virginia.** *Journal of the American Society of Agronomy*, Vol. XXI, p. 355. Washington, 1929.

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REEVES, R. G. **Nuclear and cytoplasmic division in the microsporogenesis of alfalfa.** *American Journal of Botany*, Vol. XVII, No. 1, p. 29. Lancaster, 1930.

SPAFFORD, W. J. **The control of drifting sand.** *Journal of Agriculture of South Australia*, Vol. XXXII, p. 700. Adelaide, 1929.

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UNITED STATES DEPARTMENT OF AGRICULTURE. *Farmers' Bulletin*, No. 1602. **Reed canary grass.** By H. A. Schoth. Washington, D.C., 1929.

WALDRON, L. R. **Alfalfa seed production.** Paper prepared for Seed Growers' School, Fargo, North Dakota, 1929.

WECKE, ... **Die intensive Grünlandwirtschaft in den Gebirgslagen Sachsens (unter Berücksichtigung der Genossenschaftsweiden.)** [Intensive grassland cultivation in the mountainous districts of Saxony, with special reference to the communal pastures.] *Mitt. dtsch. Landwirtschaftsgesellschaft.* Vol. II, p. 1083, 1929. Abstract in *Fortschritte der Landwirtschaft*, Vol. V, No. 5, p. 191. Berlin, 1930.

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(*c*) RECENT BOOK PUBLICATIONS.

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FALKE, Friedrich. **Die wichtigsten Gräser auf Wiesen und Weiden.** [The most important meadow and pasture grasses.] Pub. Paul Parey, Berlin 1929, pp. 68, 28 drawings. Price 4s. Reviewed: *Grünland u. Landeskultur*, Vol. VII, No. 1, p. 3, 1930.

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HAAS, Paul, and HILL, T. G. **An introduction to the chemistry of plant products.** Pub. Longmans, Green & Co. Vol. I, On the nature and significance of the commoner organic compounds of plants; 4th edition, pub. 1928, pp. 546. Price 18s. Vol. II, Metabolic processes; 2nd edition, 1929, pp. 228. Price 10s. 6d.

HOLLAND, J. H. **A textbook of tropical agriculture.** 2nd edition. Pub. London, 1929.

VI. CONCLUDING NOTES.

For the more efficient working of the Bureau, authors of papers are requested to send, whenever possible, a short abstract of the results contained in such publications to the Bureau for filing in the Library, and subsequent inclusion in the Bulletin.

We hope to include in a subsequent issue short abstracts of the papers read at the Scandinavian Agricultural Research (Fourth) Conference at Helsingfors, in July, 1929.

The Bulletin from this Bureau is being issued to all research workers associated with herbage plant problems throughout the Empire. We should be glad if any person who wishes to receive a copy would write to the Bureau in order that his name may be placed on the mailing list. This will assure receipt of such publications and circulars as are issued subsequently by the Bureau.

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